

# GLOBAL MARKETS FOR SPECTROSCOPY EQUIPMENT



IAS004E  
January 2013

Shalini Shahani Dewan  
*Project Analyst*

ISBN: 0-89336-845-8

**bcc** | Research  
Market Forecasting

**BCC Research**  
49 Walnut Park, Building 2  
Wellesley, MA 02481  
866-285-7215, 781-489-7301  
[www.bccresearch.com](http://www.bccresearch.com)  
Custom Reports: [carol.laverty@bccresearch.com](mailto:carol.laverty@bccresearch.com)

**TABLE OF CONTENTS**

<b>TOPIC</b>	<b>PAGE NO.</b>
CHAPTER 1 INTRODUCTION	1
STUDY OBJECTIVES	1
REASONS FOR DOING THE STUDY	1
CONTRIBUTIONS OF THE STUDY AND INTENDED AUDIENCE	1
SCOPE OF THE STUDY	2
METHODOLOGY	2
INFORMATION SOURCES	2
ABOUT THE AUTHOR	2
RELATED BCC RESEARCH REPORTS	3
BCC ONLINE SERVICES	3
DISCLAIMER	3
CHAPTER 2 SUMMARY	5
SUMMARY TABLE GLOBAL REVENUE OF SPECTROSCOPY MARKET, THROUGH 2017 (\$ MILLIONS)	6
SUMMARY FIGURE GLOBAL REVENUE OF SPECTROSCOPY MARKET, 2010-2017 (\$ MILLIONS)	6
CHAPTER 3 OVERVIEW	8
TABLE 1 ULTRAVIOLET (UV) AND INFRARED (IR) LIGHT REGION	9
TABLE 2 THE ELECTROMAGNETIC SPECTRUM BY WAVELENGTH	9
PHYSICAL QUANTITIES MEASURED AND TYPES OF SPECTROSCOPY	10
ABSORPTION SPECTROSCOPY	10
TABLE 3 TYPES OF ABSORPTION SPECTROSCOPY	11
EMISSION SPECTROSCOPY	11
SCATTERING SPECTROSCOPY	11
HISTORY OF SPECTROSCOPY	12
TABLE 4 HISTORIC EVENTS IN SPECTROSCOPY, 1224-1989	12
SPECTROSCOPIC INSTRUMENTS	14
TABLE 5 SPECTROSCOPIC INSTRUMENTS AND TECHNIQUES	14
SPECTROSCOPY IN CHEMICAL ANALYSIS	14
TABLE 6 TYPES OF SPECTROSCOPY	15
MOLECULAR SPECTROSCOPY	15
INFRARED (IR) SPECTROSCOPY	16
Infrared (IR) Spectroscopy Instrumentation	16
Types of Infrared (IR) Spectroscopy	16
Near-Infrared (NIR) Spectroscopy	16
Fourier Transform Infrared (FTIR) Spectroscopy	17
UV-VIS SPECTROSCOPY	17
Ultraviolet-Visible (UV-Vis) Spectroscopy Instrumentation	17
RAMAN SPECTROSCOPY	18
Raman Spectroscopy Instrumentation	18
Types of Raman Spectroscopy	18
Resonance Raman Spectroscopy	18
Surface-Enhanced Spectroscopy (SERS)	19
Surface-Enhanced Raman Spectroscopy (SERS) Instrumentation	19
NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY	19

<b>TOPIC</b>	<b>PAGE NO.</b>
Nuclear Magnetic Resonance (NMR) Spectroscopy Instrumentation	19
ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY	20
Electron Spin Resonance (ESR) Spectroscopy Instrumentation	20
ATOMIC SPECTROSCOPY	20
ATOMIC ABSORPTION SPECTROSCOPY	20
Atomic Absorption (AA) Spectroscopy Instrumentation	21
X-RAY SPECTROSCOPY	21
X-Ray Spectroscopy Instrumentation	21
ARC/SPARK SPECTROSCOPY	21
Arc/Spark Spectroscopy Instrumentation	22
PLASMA SPECTROSCOPY	22
Plasma Spectroscopy Instrumentation	22
MASS SPECTROSCOPY	22
MASS SPECTROSCOPY (MS) INSTRUMENTATION	23
HYPHENATED SPECTROSCOPY	23
GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GC-MS)	23
Gas Chromatography-Mass Spectrometry (GC-MS) Instrumentation	23
LIQUID CHROMATOGRAPHY-MASS SPECTROSCOPY (LC-MS)	24
OTHER TYPES OF SPECTROSCOPY	24
MICROWAVE SPECTROSCOPY	24
Microwave Spectroscopy Instrumentation	24
MOSSBAUER SPECTROSCOPY	24
Mossbauer Spectroscopy Instrumentation	25
FLAME PHOTOMETRY SPECTROSCOPY	25
TYPES OF ANALYSIS	25
BULK ANALYSIS	25
<i>TABLE 7 SPECTROSCOPIC BULK ANALYSIS</i>	26
MIXTURE ANALYSIS	26
<i>TABLE 8 SPECTROSCOPIC MIXTURE ANALYSIS</i>	27
MICROANALYSIS	27
<i>TABLE 9 MICROANALYSIS</i>	27
SURFACE ANALYSIS	27
<i>TABLE 10 SPECTROSCOPIC SURFACE ANALYSIS</i>	28
CHAPTER 4 REGULATORY ASPECTS	30
NEW PRODUCTS APPROVED FROM 2009 TO 2012	31
<i>TABLE 11 FOOD AND DRUG ADMINISTRATION (FDA)-APPROVED NEW PRODUCTS, 2009-2012</i>	32
RECALLS AND SAFETY ALERTS	33
<i>TABLE 12 RECALL CLASSIFICATION</i>	34
<i>TABLE 13 RECALLS IN PRODUCTS USING SPECTROSCOPY, 2010-2012</i>	35
CHAPTER 5 NEW DEVELOPMENTS	37
NEW PARTNERSHIPS, MERGERS AND ACQUISITIONS	37
NEW PRODUCTS	38
<i>TABLE 14 INNOVATIONS IN SPECTROSCOPY, 2009-2012</i>	38
CHAPTER 6 GLOBAL MARKETS	43

<b>TOPIC</b>	<b>PAGE NO.</b>
MARKET ANALYSIS	43
MARKET BY TYPE	44
MARKET OVERVIEW	44
MARKET REVENUE	47
TABLE 15 REVENUE OF SPECTROSCOPIES, BY TYPE, THROUGH 2017 (\$ MILLIONS)	48
FIGURE 1 REVENUE OF SPECTROSCOPIES, BY TYPE, 2010-2017 (\$ MILLIONS)	48
MARKET SHARE	48
TABLE 16 MARKET SHARE OF SPECTROSCOPIES REVENUE BY TYPE, 2011 (%)	49
FIGURE 2 MARKET SHARE OF REVENUE OF SPECTROSCOPIES, BY TYPE, 2011 (%)	49
MARKET BY REGION	49
MARKET OVERVIEW	49
MARKET REVENUE	55
TABLE 17 GLOBAL REVENUE OF SPECTROSCOPY, BY REGION, THROUGH 2017 (\$ MILLIONS)	55
FIGURE 3 GLOBAL REVENUE OF SPECTROSCOPY, BY REGION, 2010-2017 (\$ MILLIONS)	55
MARKET SHARE	56
TABLE 18 MARKET SHARE OF SPECTROSCOPY REVENUE, BY REGION, 2011 (%)	56
FIGURE 4 MARKET SHARE OF SPECTROSCOPY REVENUE, BY REGION, 2011 (%)	56
MARKET REVENUE BY REGION FOR EACH TYPE OF SPECTROSCOPY	56
MOLECULAR SPECTROSCOPY	56
Market Overview	56
Market Revenue	58
TABLE 19 MOLECULAR SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	59
FIGURE 5 MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	59
Market Share	59
TABLE 20 MARKET SHARE OF MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2011 (%)	60
FIGURE 6 MARKET SHARE OF MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2011 (%)	60
ATOMIC SPECTROSCOPY	60
Market Overview	60
Market Revenue	62
TABLE 21 ATOMIC SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	62
FIGURE 7 ATOMIC SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	62
Market Share	63
TABLE 22 MARKET SHARE OF ATOMIC SPECTROSCOPY REVENUE BY REGION, 2011 (%)	63
FIGURE 8 MARKET SHARE OF ATOMIC SPECTROSCOPY REVENUE BY REGION, 2011 (%)	63
MASS AND HYPHENATED SPECTROSCOPY	63
Market Overview	63
Market Revenue	64
TABLE 23 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	65
FIGURE 9 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	65
Market Share	65
TABLE 24 MARKET SHARE OF MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2011 (%)	66
FIGURE 10 MARKET SHARE OF MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2011 (%)	66
OTHER SPECTROSCOPY	66

<b>TOPIC</b>	<b>PAGE NO.</b>
Market Overview	66
Market Revenue	67
<i>TABLE 25 OTHER SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	67
<i>FIGURE 11 OTHER SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	67
Market Share	68
<i>TABLE 26 MARKET SHARE OF OTHER SPECTROSCOPY REVENUE BY REGION, 2011 (%)</i>	68
<i>FIGURE 12 MARKET SHARE OF OTHER SPECTROSCOPY REVENUE BY REGION, 2011 (%)</i>	68
MARKET BY APPLICATION/END USER	69
MARKET OVERVIEW	69
Pharmaceutical and Biotechnology Industry	69
Environmental Science Industry	70
Food and Beverage Industry	72
Other Industries	73
MARKET REVENUE	75
<i>TABLE 27 GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	76
<i>FIGURE 13 GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2010-2017 (\$ MILLIONS)</i>	76
MARKET SHARE	76
<i>TABLE 28 MARKET SHARE OF GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2011 (%)</i>	77
<i>FIGURE 14 MARKET SHARE OF GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2011 (%)</i>	77
CHAPTER 7 MARKET ANALYSIS FOR MOLECULAR SPECTROSCOPY	79
MARKET BY TYPE	80
<i>TABLE 29 MOLECULAR SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	81
<i>FIGURE 15 MOLECULAR SPECTROSCOPY REVENUE BY TYPE, 2010-2017 (\$ MILLIONS)</i>	82
MARKET BY REGION	82
INFRARED (IR) SPECTROSCOPY	83
<i>TABLE 30 INFRARED SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	84
<i>FIGURE 16 INFRARED SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	84
RAMAN SPECTROSCOPY	85
<i>TABLE 31 RAMAN SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	86
<i>FIGURE 17 RAMAN SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	86
ULTRAVIOLET-VISIBLE SPECTROSCOPY (UV-VIS)	87
<i>TABLE 32 ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	87
<i>FIGURE 18 ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	87
NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (NMR)	88
<i>TABLE 33 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	89
<i>FIGURE 19 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	89
ELECTRON SPIN RESONANCE SPECTROSCOPY	90
<i>TABLE 34 ELECTRON SPIN RESONANCE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	91

<b>TOPIC</b>	<b>PAGE NO.</b>
<i>FIGURE 20 ELECTRON SPIN RESONANCE SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	91
MARKET BY APPLICATION/END USER	92
<i>TABLE 35 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	92
<i>FIGURE 21 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY, BY END USERS, 2010-2017 (\$ MILLIONS)</i>	93
PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY	94
<i>TABLE 36 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	95
<i>FIGURE 22 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	95
ENVIRONMENTAL SCIENCE INDUSTRY	96
<i>TABLE 37 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	96
<i>FIGURE 23 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	96
FOOD AND BEVERAGE INDUSTRY	97
<i>TABLE 38 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	98
<i>FIGURE 24 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	99
OTHER INDUSTRIES	99
<i>TABLE 39 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)</i>	100
<i>FIGURE 25 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)</i>	101
INDUSTRY STRUCTURE	102
INFRARED SPECTROSCOPY	102
Market Leaders	102
<i>TABLE 40 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF INFRARED SPECTROSCOPY</i>	102
Market Share	104
<i>TABLE 41 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN INFRARED (IR) SPECTROSCOPY, 2011 (%)</i>	104
<i>FIGURE 26 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN INFRARED (IR) SPECTROSCOPY, 2011 (%)</i>	104
ULTRAVIOLET-VISIBLE (UV-VIS)	105
Market Leaders	105
<i>TABLE 42 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY</i>	105
Market Share	105
<i>TABLE 43 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY, 2011 (%)</i>	106
<i>FIGURE 27 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY, 2011 (%)</i>	106
NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY	107
Market Leaders	107
<i>TABLE 44 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY</i>	107
Market Share	107

<b>TOPIC</b>	<b>PAGE NO.</b>
<i>TABLE 45 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY, 2011 (%)</i>	107
<i>FIGURE 28 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY, 2011 (%)</i>	107
ELECTRON SPIN RESONANCE SPECTROSCOPY	108
Market Leaders	108
<i>TABLE 46 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY</i>	108
Market Share	108
<i>TABLE 47 MARKET SHARE FOR THE MANUFACTURERS OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY, 2011 (%)</i>	109
<i>FIGURE 29 MARKET SHARE FOR THE MANUFACTURERS OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY, 2011 (%)</i>	109
CHAPTER 8 MARKET ANALYSIS FOR ATOMIC SPECTROSCOPY	111
MARKET BY TYPE	111
<i>TABLE 48 ATOMIC SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	113
<i>FIGURE 30 ATOMIC SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	113
MARKET BY REGION	114
X-RAY SPECTROSCOPY	114
<i>TABLE 49 X-RAY SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	115
<i>FIGURE 31 X-RAY SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	116
ATOMIC ABSORPTION SPECTROSCOPY	116
<i>TABLE 50 ATOMIC ABSORPTION SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	117
<i>FIGURE 32 ATOMIC ABSORPTION SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	117
ARC/SPARK SPECTROSCOPY	118
<i>TABLE 51 ARC/SPARK SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	118
<i>FIGURE 33 ARC/SPARK SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	118
PLASMA SPECTROSCOPY	119
<i>TABLE 52 PLASMA SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	120
<i>FIGURE 34 PLASMA SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	120
MARKET BY APPLICATION/END USER	121
<i>TABLE 53 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	121
<i>FIGURE 35 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY, BY END USERS, 2010-2017 (\$ MILLIONS)</i>	121
PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY	122
<i>TABLE 54 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	123
<i>FIGURE 36 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	124
ENVIRONMENTAL SCIENCE INDUSTRY	124
<i>TABLE 55 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	125
<i>FIGURE 37 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	125
FOOD AND BEVERAGE INDUSTRY	126

<b>TOPIC</b>	<b>PAGE NO.</b>
<i>TABLE 56 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	127
<i>FIGURE 38 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	127
OTHER INDUSTRIES	128
<i>TABLE 57 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)</i>	129
<i>FIGURE 39 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)</i>	129
INDUSTRY STRUCTURE	130
X-RAY SPECTROSCOPY	130
Market Leaders	130
<i>TABLE 58 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF X-RAY SPECTROSCOPY, THROUGH 2017</i>	130
Market Share	131
<i>TABLE 59 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN X-RAY SPECTROSCOPY, 2011 (%)</i>	131
<i>FIGURE 40 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN X-RAY SPECTROSCOPY, 2011 (%)</i>	131
ABSORPTION SPECTROSCOPY	132
Market Leaders	132
<i>TABLE 60 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF ABSORPTION SPECTROSCOPY INSTRUMENTS, THROUGH 2017</i>	133
Market Share	133
<i>TABLE 61 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ATOMIC ABSORPTION SPECTROSCOPY, 2011 (%)</i>	134
<i>FIGURE 41 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ATOMIC ABSORPTION SPECTROSCOPY, 2011 (%)</i>	134
PLASMA SPECTROSCOPY	135
Market Leaders	135
<i>TABLE 62 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF PLASMA SPECTROSCOPY INSTRUMENTS, 2011</i>	135
Market Share	135
<i>TABLE 63 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN PLASMA SPECTROSCOPY, 2011 (%)</i>	136
<i>FIGURE 42 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN PLASMA SPECTROSCOPY, 2011 (%)</i>	136
ARC/SPARK SPECTROSCOPY	137
Market Leaders	137
<i>TABLE 64 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF ARC/SPARK SPECTROSCOPY INSTRUMENTS, 2011</i>	137
Market Share	137
<i>TABLE 65 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ARC/SPARK SPECTROSCOPY, 2011 (%)</i>	137
<i>FIGURE 43 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ARC/SPARK SPECTROSCOPY, 2011 (%)</i>	137
CHAPTER 9 MARKET ANALYSIS FOR MASS AND HYPHENATED SPECTROSCOPY	140
MARKET BY TYPE	140
<i>TABLE 66 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	141



<b>TOPIC</b>	<b>PAGE NO.</b>
<i>FIGURE 44 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	141
MARKET BY REGION	142
MASS SPECTROSCOPY	143
<i>TABLE 67 GLOBAL REVENUE OF MASS SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	144
<i>FIGURE 45 GLOBAL REVENUE OF MASS SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	145
HYPHENATED SPECTROSCOPY	145
<i>TABLE 68 REVENUE OF HYPHENATED SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	146
<i>FIGURE 46 REVENUE OF HYPHENATED SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	146
MARKET BY APPLICATION/END USER	147
<i>TABLE 69 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPES BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	147
<i>FIGURE 47 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPES BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	148
PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY	149
<i>TABLE 70 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	149
<i>FIGURE 48 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	149
ENVIRONMENTAL SCIENCE INDUSTRY	150
<i>TABLE 71 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	151
<i>FIGURE 49 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	151
FOOD AND BEVERAGE INDUSTRY	152
<i>TABLE 72 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	153
<i>FIGURE 50 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	153
OTHER INDUSTRIES	154
<i>TABLE 73 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)</i>	155
<i>FIGURE 51 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)</i>	155
INDUSTRY STRUCTURE	156
MASS SPECTROSCOPY	156
Market Leaders	156
<i>TABLE 74 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MASS SPECTROSCOPY</i>	156
Market Share	157
<i>TABLE 75 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MASS SPECTROSCOPY, 2011 (%)</i>	157
<i>FIGURE 52 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MASS SPECTROSCOPY, 2011 (%)</i>	158
HYPHENATED SPECTROSCOPY	158
Market Leaders	158

<b>TOPIC</b>	<b>PAGE NO.</b>
<i>TABLE 76 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF HYPHENATED SPECTROSCOPY</i>	158
Market Share	158
<i>TABLE 77 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN HYPHENATED SPECTROSCOPY, 2011 (%)</i>	159
<i>FIGURE 53 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN HYPHENATED SPECTROSCOPY, 2011 (%)</i>	159
<b>CHAPTER 10 MARKETS FOR OTHER TYPES OF SPECTROSCOPY</b>	<b>161</b>
<b>MARKET BY TYPE</b>	<b>161</b>
<i>TABLE 78 OTHER SPECTROSCOPIES REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	162
<i>FIGURE 54 OTHER SPECTROSCOPIES REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	163
<b>MARKET BY REGION</b>	<b>163</b>
<b>MICROWAVE SPECTROSCOPY</b>	<b>164</b>
<i>TABLE 79 MICROWAVE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	164
<i>FIGURE 55 MICROWAVE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	165
<b>MOSSBAUER SPECTROSCOPY</b>	<b>165</b>
<i>TABLE 80 MOSSBAUER SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	165
<i>FIGURE 56 MOSSBAUER SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	165
<b>FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY</b>	<b>166</b>
<i>TABLE 81 FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	167
<i>FIGURE 57 FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)</i>	167
<b>MARKET BY APPLICATION/END USER</b>	<b>167</b>
<i>TABLE 82 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES BY END USERS, THROUGH 2017 (\$ MILLIONS)</i>	168
<i>FIGURE 58 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES BY END USERS, 2010-2017 (\$ MILLIONS)</i>	168
<b>PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY</b>	<b>169</b>
<i>TABLE 83 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	169
<i>FIGURE 59 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	169
<b>ENVIRONMENTAL SCIENCE INDUSTRY</b>	<b>170</b>
<i>TABLE 84 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	171
<i>FIGURE 60 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	172
<b>FOOD AND BEVERAGE INDUSTRY</b>	<b>172</b>
<i>TABLE 85 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)</i>	173
<i>FIGURE 61 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)</i>	173
<b>OTHER INDUSTRIES</b>	<b>174</b>
<i>TABLE 86 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)</i>	175

<b>TOPIC</b>	<b>PAGE NO.</b>
<i>FIGURE 62 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPIES IN OTHER INDUSTRIES, 2010-2017</i>	175
INDUSTRY STRUCTURE	176
MICROWAVE SPECTROSCOPY	176
Market Leaders	176
<i>TABLE 87 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MICROWAVE SPECTROSCOPY</i>	176
Market Share	176
<i>TABLE 88 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MICROWAVE SPECTROSCOPY, 2011 (%)</i>	176
<i>FIGURE 63 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MICROWAVE SPECTROSCOPY, 2011 (%)</i>	177
FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY	177
Market Leaders	177
<i>TABLE 89 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF FLUORESCENCE AND FLAME PHOTOMETRY/ FLAME EMISSION SPECTROSCOPY</i>	177
Market Share	178
<i>TABLE 90 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN FLUORESCENCE AND FLAME PHOTOMETRY/ FLAME EMISSION SPECTROSCOPY, 2011 (%)</i>	178
<i>FIGURE 64 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY, 2011 (%)</i>	178
MOSSBAUER SPECTROSCOPY	179
Market Leaders	179
<i>TABLE 91 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MOSSBAUER SPECTROSCOPY</i>	179
Market Share	179
<i>TABLE 92 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MOSSBAUER SPECTROSCOPY, 2011 (%)</i>	179
<i>FIGURE 65 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MOSSBAUER SPECTROSCOPY, 2011 (%)</i>	179
CHAPTER 11 PATENT ANALYSIS	182
PATENTS BY YEAR	182
<i>TABLE 93 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012</i>	182
<i>FIGURE 66 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012</i>	182
<i>FIGURE 67 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012 (%)</i>	183
PATENTS BY CATEGORY	184
<i>TABLE 94 NUMBER OF U.S. PATENTS BY CATEGORY, 2009-2012</i>	184
<i>FIGURE 68 NUMBER OF U.S. PATENTS BY CATEGORY, 2009-2012</i>	184
PATENTS BY TYPE	184
<i>TABLE 95 NUMBER OF U.S. PATENTS BY TYPE, 2009-2012</i>	185
<i>FIGURE 69 NUMBER OF U.S. PATENTS BY TYPE, 2009-2012</i>	186
PATENTS BY COMPANY	186
<i>TABLE 96 NUMBER OF U.S. PATENTS BY COMPANY, 2009-2012</i>	186
PATENTS BY COUNTRY	189
<i>TABLE 97 NUMBER OF U.S. PATENTS BY COUNTRY, 2009-2012</i>	189
PATENTS BY ASSIGNEE	190
<i>TABLE 98 NUMBER OF U.S. PATENTS BY ASSIGNEE TYPE, 2009-2012</i>	190
<i>FIGURE 70 NUMBER OF U.S. PATENTS BY ASSIGNEE TYPE, 2009-2012</i>	191

<b>TOPIC</b>	<b>PAGE NO.</b>
CHAPTER 12 CURRENT SITUATION	193
SENSITIVITY AND PERFORMANCE	194
OPTICAL CONFIGURATION	194
SPECTROPHOTOMETER SIZE AND LOW COST	194
CHAPTER 13 COMPANY PROFILES	197
A2 TECHNOLOGIES	197
AABSPEC INSTRUMENTATION CORP.	197
ABB ANALYTICAL/ABB PROCESS ANALYTICS	198
AGILENT TECHNOLOGIES	198
AHURA SCIENTIFIC, INC.	199
ANALYTIK JENA USA	200
ANASYS INSTRUMENTS CORP.	200
ANGSTROM, INC.	200
APPLIED BIOSYSTEMS	201
AURORA INSTRUMENTS, LTD.	201
AVANTES, INC.	202
B&W TEK, INC.	202
BECKMAN COULTER, INC.	202
BRUKER AXS, INC.	203
BRUKER BIOSPIN CORP.	204
BRUKER DALTONICS, INC.	204
BRUKER OPTICS, INC.	205
BUCK SCIENTIFIC, INC.	205
CINAFLONE SCIENTIFIC INSTRUMENTS CORP.	206
CRAIC TECHNOLOGIES, INC.	206
CVI MELLES GRIOT	207
CYCLOTRON INC.	208
DANAHER CORP. /HACH CO.	208
DIGILAB, INC.	210
DIONEX CORP.	210
EDAX	211
ENWAVE OPTRONICS, INC.	212
FILMETRICS, INC.	212
FOSS NIRSYSTEMS, INC.	212
GAMMA-LAB DEVELOPMENT S.L.	213
GBC SCIENTIFIC EQUIPMENT	213
GRATINGWORKS CO. LTD. USA	214
HITACHI HIGH TECHNOLOGIES AMERICA	214
HORIBA JOBIN YVON, INC.	214
INNOV-X SYSTEMS, INC.	215
INPHOTONICS, INC.	215
ISS, INC.	216
JASCO, INC.	216
JEOL USA, INC.	217
KAISER OPTICAL SYSTEMS, INC.	218

<b>TOPIC</b>	<b>PAGE NO.</b>
LECO CORP.	218
LIFE TECHNOLOGIES CORP.	218
MIDAC CORP.	219
MK PHOTONICS, INC.	219
NEWPORT CORP.	219
OCEAN OPTICS, INC.	220
OLIS, INC.	221
OXFORD INSTRUMENTS PLASMA TECHNOLOGY	221
PANALYTICAL, INC.	221
PERKINELMER, INC.	222
PHOTON TECHNOLOGY INTERNATIONAL	222
PICARRO, INC.	223
PRINCETON INSTRUMENTS/ACTON RESEARCH	223
PROTASIS	224
RENISHAW, INC.	224
RIGAKU AMERICAS	224
RITVERC ISOTOPE PRODUCTS	225
SEE CO.	226
SENSOR TECHNOLOGIES LLC	226
SHIMADZU SCIENTIFIC INSTRUMENTS, INC.	226
SPECTRAL PRODUCTS	227
SPECTRO ANALYTICAL INSTRUMENTS, INC.	228
STELLAR NET, INC.	228
TE-HSNABEXPORT/TENEX	229
TELEDYNE LEEMAN LABS	229
THERMOFISHER SCIENTIFIC, INC.	230
TIGER OPTICS LLC	231
VARIAN, INC.	231
WATERS CORP.	232
WILKS ENTERPRISE, INC.	233
X-RITE, INC.	233
ZELTEX, INC.	234
CHAPTER 14 APPENDIX I-ABBREVIATIONS	236
<i>TABLE 99 ABBREVIATIONS</i>	236

## LIST OF TABLES

TABLE HEADING	PAGE NO.
SUMMARY TABLE GLOBAL REVENUE OF SPECTROSCOPY MARKET, THROUGH 2017 (\$ MILLIONS)	6
TABLE 1 ULTRAVIOLET (UV) AND INFRARED (IR) LIGHT REGION	9
TABLE 2 THE ELECTROMAGNETIC SPECTRUM BY WAVELENGTH	9
TABLE 3 TYPES OF ABSORPTION SPECTROSCOPY	11
TABLE 4 HISTORIC EVENTS IN SPECTROSCOPY, 1224-1989	12
TABLE 5 SPECTROSCOPIC INSTRUMENTS AND TECHNIQUES	14
TABLE 6 TYPES OF SPECTROSCOPY	15
TABLE 7 SPECTROSCOPIC BULK ANALYSIS	26
TABLE 8 SPECTROSCOPIC MIXTURE ANALYSIS	27
TABLE 9 MICROANALYSIS	27
TABLE 10 SPECTROSCOPIC SURFACE ANALYSIS	28
TABLE 11 FOOD AND DRUG ADMINISTRATION (FDA)-APPROVED NEW PRODUCTS, 2009-2012	32
TABLE 12 RECALL CLASSIFICATION	34
TABLE 13 RECALLS IN PRODUCTS USING SPECTROSCOPY, 2010-2012	35
TABLE 14 INNOVATIONS IN SPECTROSCOPY, 2009-2012	38
TABLE 15 REVENUE OF SPECTROSCOPES, BY TYPE, THROUGH 2017 (\$ MILLIONS)	48
TABLE 16 MARKET SHARE OF SPECTROSCOPES REVENUE BY TYPE, 2011 (%)	49
TABLE 17 GLOBAL REVENUE OF SPECTROSCOPY, BY REGION, THROUGH 2017 (\$ MILLIONS)	55
TABLE 18 MARKET SHARE OF SPECTROSCOPY REVENUE, BY REGION, 2011 (%)	56
TABLE 19 MOLECULAR SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	59
TABLE 20 MARKET SHARE OF MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2011 (%)	60
TABLE 21 ATOMIC SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	62
TABLE 22 MARKET SHARE OF ATOMIC SPECTROSCOPY REVENUE BY REGION, 2011 (%)	63
TABLE 23 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	65
TABLE 24 MARKET SHARE OF MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2011 (%)	66
TABLE 25 OTHER SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	67
TABLE 26 MARKET SHARE OF OTHER SPECTROSCOPY REVENUE BY REGION, 2011 (%)	68
TABLE 27 GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)	76
TABLE 28 MARKET SHARE OF GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2011 (%)	77
TABLE 29 MOLECULAR SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	81
TABLE 30 INFRARED SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	84
TABLE 31 RAMAN SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	86
TABLE 32 ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	87
TABLE 33 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	89
TABLE 34 ELECTRON SPIN RESONANCE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	91
TABLE 35 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)	92
TABLE 36 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)	95
TABLE 37 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)	96

<b>TABLE HEADING</b>	<b>PAGE NO.</b>
TABLE 38 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)	98
TABLE 39 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)	100
TABLE 40 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF INFRARED SPECTROSCOPY	102
TABLE 41 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN INFRARED (IR) SPECTROSCOPY, 2011 (%)	104
TABLE 42 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY	105
TABLE 43 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY, 2011 (%)	106
TABLE 44 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY	107
TABLE 45 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY, 2011 (%)	107
TABLE 46 MARKET LEADERS FOR THE MANUFACTURE/DISTRIBUTION OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY	108
TABLE 47 MARKET SHARE FOR THE MANUFACTURERS OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY, 2011 (%)	109
TABLE 48 ATOMIC SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	113
TABLE 49 X-RAY SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	115
TABLE 50 ATOMIC ABSORPTION SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	117
TABLE 51 ARC/SPARK SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	118
TABLE 52 PLASMA SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	120
TABLE 53 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY BY END USERS, THROUGH 2017 (\$ MILLIONS)	121
TABLE 54 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)	123
TABLE 55 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)	125
TABLE 56 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)	127
TABLE 57 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)	129
TABLE 58 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF X-RAY SPECTROSCOPY, THROUGH 2017	130
TABLE 59 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN X-RAY SPECTROSCOPY, 2011 (%)	131
TABLE 60 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF ABSORPTION SPECTROSCOPY INSTRUMENTS, THROUGH 2017	133
TABLE 61 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ATOMIC ABSORPTION SPECTROSCOPY, 2011 (%)	134
TABLE 62 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF PLASMA SPECTROSCOPY INSTRUMENTS, 2011	135
TABLE 63 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN PLASMA SPECTROSCOPY, 2011 (%)	136
TABLE 64 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF ARC/SPARK SPECTROSCOPY INSTRUMENTS, 2011	137
TABLE 65 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ARC/SPARK SPECTROSCOPY, 2011 (%)	137

<b>TABLE HEADING</b>	<b>PAGE NO.</b>
TABLE 66 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	141
TABLE 67 GLOBAL REVENUE OF MASS SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)	144
TABLE 68 REVENUE OF HYPHENATED SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)	146
TABLE 69 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPES BY END USERS, THROUGH 2017 (\$ MILLIONS)	147
TABLE 70 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)	149
TABLE 71 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)	151
TABLE 72 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)	153
TABLE 73 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)	155
TABLE 74 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MASS SPECTROSCOPY	156
TABLE 75 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MASS SPECTROSCOPY, 2011 (%)	157
TABLE 76 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF HYPHENATED SPECTROSCOPY	158
TABLE 77 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN HYPHENATED SPECTROSCOPY, 2011 (%)	159
TABLE 78 OTHER SPECTROSCOPES REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	162
TABLE 79 MICROWAVE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	164
TABLE 80 MOSSBAUER SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	165
TABLE 81 FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	167
TABLE 82 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES BY END USERS, THROUGH 2017 (\$ MILLIONS)	168
TABLE 83 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)	169
TABLE 84 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE ENVIRONMENTAL SCIENCES INDUSTRY, THROUGH 2017 (\$ MILLIONS)	171
TABLE 85 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE FOOD AND BEVERAGE INDUSTRY, THROUGH 2017 (\$ MILLIONS)	173
TABLE 86 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN OTHER INDUSTRIES, THROUGH 2017 (\$ MILLIONS)	175
TABLE 87 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MICROWAVE SPECTROSCOPY	176
TABLE 88 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MICROWAVE SPECTROSCOPY, 2011 (%)	176
TABLE 89 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF FLUORESCENCE AND FLAME PHOTOMETRY/ FLAME EMISSION SPECTROSCOPY	177
TABLE 90 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN FLUORESCENCE AND FLAME PHOTOMETRY/ FLAME EMISSION SPECTROSCOPY, 2011 (%)	178
TABLE 91 MARKET LEADERS IN THE MANUFACTURE/DISTRIBUTION OF MOSSBAUER SPECTROSCOPY	179
TABLE 92 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MOSSBAUER SPECTROSCOPY, 2011 (%)	179
TABLE 93 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012	182



<b>TABLE HEADING</b>	<b>PAGE NO.</b>
TABLE 94 NUMBER OF U.S. PATENTS BY CATEGORY, 2009-2012	184
TABLE 95 NUMBER OF U.S. PATENTS BY TYPE, 2009-2012	185
TABLE 96 NUMBER OF U.S. PATENTS BY COMPANY, 2009-2012	186
TABLE 97 NUMBER OF U.S. PATENTS BY COUNTRY, 2009-2012	189
TABLE 98 NUMBER OF U.S. PATENTS BY ASSIGNEE TYPE, 2009-2012	190
TABLE 99 ABBREVIATIONS	236

## LIST OF FIGURES

FIGURE TITLE	PAGE NO.
SUMMARY FIGURE GLOBAL REVENUE OF SPECTROSCOPY MARKET, 2010-2017 (\$ MILLIONS)	6
FIGURE 1 REVENUE OF SPECTROSCOPES, BY TYPE, 2010-2017 (\$ MILLIONS)	48
FIGURE 2 MARKET SHARE OF REVENUE OF SPECTROSCOPES, BY TYPE, 2011 (%)	49
FIGURE 3 GLOBAL REVENUE OF SPECTROSCOPY, BY REGION, 2010-2017 (\$ MILLIONS)	55
FIGURE 4 MARKET SHARE OF SPECTROSCOPY REVENUE, BY REGION, 2011 (%)	56
FIGURE 5 MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	59
FIGURE 6 MARKET SHARE OF MOLECULAR SPECTROSCOPY REVENUE BY REGION, 2011 (%)	60
FIGURE 7 ATOMIC SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	62
FIGURE 8 MARKET SHARE OF ATOMIC SPECTROSCOPY REVENUE BY REGION, 2011 (%)	63
FIGURE 9 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	65
FIGURE 10 MARKET SHARE OF MASS AND HYPHENATED SPECTROSCOPY REVENUE BY REGION, 2011 (%)	66
FIGURE 11 OTHER SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	67
FIGURE 12 MARKET SHARE OF OTHER SPECTROSCOPY REVENUE BY REGION, 2011 (%)	68
FIGURE 13 GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2010-2017 (\$ MILLIONS)	76
FIGURE 14 MARKET SHARE OF GLOBAL EXPENDITURE FOR SPECTROSCOPY BY END USERS, 2011 (%)	77
FIGURE 15 MOLECULAR SPECTROSCOPY REVENUE BY TYPE, 2010-2017 (\$ MILLIONS)	82
FIGURE 16 INFRARED SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	84
FIGURE 17 RAMAN SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	86
FIGURE 18 ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	87
FIGURE 19 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	89
FIGURE 20 ELECTRON SPIN RESONANCE SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	91
FIGURE 21 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY, BY END USERS, 2010-2017 (\$ MILLIONS)	93
FIGURE 22 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)	95
FIGURE 23 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)	96
FIGURE 24 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)	99
FIGURE 25 GLOBAL EXPENDITURE FOR MOLECULAR SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)	101
FIGURE 26 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN INFRARED (IR) SPECTROSCOPY, 2011 (%)	104
FIGURE 27 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY, 2011 (%)	106
FIGURE 28 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROSCOPY, 2011 (%)	107
FIGURE 29 MARKET SHARE FOR THE MANUFACTURERS OF ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY, 2011 (%)	109
FIGURE 30 ATOMIC SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	113
FIGURE 31 X-RAY SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	116
FIGURE 32 ATOMIC ABSORPTION SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	117

<b>FIGURE TITLE</b>	<b>PAGE NO.</b>
FIGURE 33 ARC/SPARK SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	118
FIGURE 34 PLASMA SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	120
FIGURE 35 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY, BY END USERS, 2010-2017 (\$ MILLIONS)	121
FIGURE 36 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)	124
FIGURE 37 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)	125
FIGURE 38 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)	127
FIGURE 39 GLOBAL EXPENDITURE FOR ATOMIC SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)	129
FIGURE 40 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN X-RAY SPECTROSCOPY, 2011 (%)	131
FIGURE 41 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ATOMIC ABSORPTION SPECTROSCOPY, 2011 (%)	134
FIGURE 42 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN PLASMA SPECTROSCOPY, 2011 (%)	136
FIGURE 43 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN ARC/SPARK SPECTROSCOPY, 2011 (%)	137
FIGURE 44 MASS AND HYPHENATED SPECTROSCOPY REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	141
FIGURE 45 GLOBAL REVENUE OF MASS SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)	145
FIGURE 46 REVENUE OF HYPHENATED SPECTROSCOPY BY REGION, THROUGH 2017 (\$ MILLIONS)	146
FIGURE 47 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPES BY END USERS, THROUGH 2017 (\$ MILLIONS)	148
FIGURE 48 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, THROUGH 2017 (\$ MILLIONS)	149
FIGURE 49 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)	151
FIGURE 50 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)	153
FIGURE 51 GLOBAL EXPENDITURE FOR MASS AND HYPHENATED SPECTROSCOPY IN OTHER INDUSTRIES, 2010-2017 (\$ MILLIONS)	155
FIGURE 52 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MASS SPECTROSCOPY, 2011 (%)	158
FIGURE 53 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN HYPHENATED SPECTROSCOPY, 2011 (%)	159
FIGURE 54 OTHER SPECTROSCOPES REVENUE BY TYPE, THROUGH 2017 (\$ MILLIONS)	163
FIGURE 55 MICROWAVE SPECTROSCOPY REVENUE BY REGION, THROUGH 2017 (\$ MILLIONS)	165
FIGURE 56 MOSSBAUER SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	165
FIGURE 57 FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY REVENUE BY REGION, 2010-2017 (\$ MILLIONS)	167
FIGURE 58 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES BY END USERS, 2010-2017 (\$ MILLIONS)	168
FIGURE 59 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY, 2010-2017 (\$ MILLIONS)	169
FIGURE 60 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE ENVIRONMENTAL SCIENCES INDUSTRY, 2010-2017 (\$ MILLIONS)	172

<b>FIGURE TITLE</b>	<b>PAGE NO.</b>
FIGURE 61 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN THE FOOD AND BEVERAGE INDUSTRY, 2010-2017 (\$ MILLIONS)	173
FIGURE 62 GLOBAL EXPENDITURE FOR OTHER SPECTROSCOPES IN OTHER INDUSTRIES, 2010-2017	175
FIGURE 63 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MICROWAVE SPECTROSCOPY, 2011 (%)	177
FIGURE 64 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN FLUORESCENCE AND FLAME PHOTOMETRY/FLAME EMISSION SPECTROSCOPY, 2011 (%)	178
FIGURE 65 MARKET SHARES OF MANUFACTURERS/DISTRIBUTORS IN MOSSBAUER SPECTROSCOPY, 2011 (%)	179
FIGURE 66 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012	182
FIGURE 67 NUMBER OF U.S. PATENTS BY YEAR, 2009-2012 (%)	183
FIGURE 68 NUMBER OF U.S. PATENTS BY CATEGORY, 2009-2012	184
FIGURE 69 NUMBER OF U.S. PATENTS BY TYPE, 2009-2012	186
FIGURE 70 NUMBER OF U.S. PATENTS BY ASSIGNEE TYPE, 2009-2012	191